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Joel S. Demski

A PRIMARY goal of accounting theory is to explain which accounting alternative should be used (in some particular circumstance). Numerous attempts to develop such a theory have, of course, been offered through the years. Most of these attempts have, in turn, relied on standards, such as relevance, usefulness, objectivity, fairness, and verifiability to delineate the desired alternatives. Social choice institutions also reflect this reliance on standards, with the recently formed Financial Accounting *Standards* and Cost Accounting *Standards* Boards.

Moreover, these standards are usually viewed in terms of, or applied to, the accounting measurement process, the environment in which the measurements are taken and/or used, and perceptions regarding that environment. But any such application that is removed from individual preferences—in the slightest manner—creates an insurmountable difficulty. In particular, no normative theory of accounting can be constructed using *any* such set of standards; the standards are bound incompletely and/or incorrectly to rank the accounting alternatives—thus leading to an incorrect or undefined accounting specification.

The purpose of this paper is to state and prove this impossibility result. The necessary choice theory framework is presented in the first section followed in the second section by the impossibility theorem. The third section then presents a brief discussion of the result's implications.

Choice Among Accounting Alternatives

In this initial section we shall explore the abstract notions of choice among accounting alternatives and the use of standards to characterize the accounting choice process. To begin, suppose some individual is confronted with a defined set of accounting alternatives, denoted H, that is neither null nor singular. The former, of course, admits to no problem while the latter admits to a trivial problem. We now invoke the *completeness* and *transitivity* axioms that are the hallmark feature of rational choice theory.[1]

Consider any two accounting alternatives, η and $\eta' \epsilon H$. Completeness requires that we be able to ascertain whether in the situation facing us we prefer η to η', η' to η, or are indifferent between them. And this rudimentary comparability must hold for all pairs of alternatives that are available. A convenient characterization is that of "is at least as good as," which we denote by the binary relation R. Then complete-

[1] We could, in fact, develop these axioms from more primitive ones, as in revealed preference theory; but such development is not germane to our impossibility exploration.

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ness requires that $\eta R\eta'$, $\eta' R\eta$, or both for all η, $\eta' \epsilon$H.[2]

Now consider any three alternatives η, $\eta', \eta'' \epsilon$H where $\eta R\eta'$ and $\eta' R\eta''$. Transitivity requires that, under these conditions, $\eta R\eta''$. If historical cost is deemed at least as good as current cost and current cost is deemed at least as good as price level adjusted historical cost, then historical cost is at least as good as its price level adjusted counterpart.

If, then, we elect to view accounting issues in terms of selecting or specifying an alternative that ought to be used, we must be able to say which of two alternatives is the better (or whether they are indifferent). Otherwise, we cannot hope to resolve accounting issues. These comparisons should also be transitive.[3] Otherwise, needless consumption of resources may result. Suppose, for example, that $\eta R\eta'$, $\eta' R\eta''$, but not $\eta R\eta''$. We might, in this intransitive setting, pay z dollars to switch from η'' to η', another z dollars to switch from η' to η, and another z dollars to switch from η to η''. This ensures the status quo, at a cost of $3z$ dollars, and hardly seems satisfactory.

Completeness and transitivity are, in fact, sufficient to explore a variety of issues, including questions relating to the existence of at least one most preferred alternative. But since accounting alternatives relate to information system alternatives, we can develop a far more revealing framework by invoking additional axioms sufficient to ensure the expected utility hypothesis. We shall, that is, make additional assumptions that ensure existence of utility and probability functions such that the ordering relation R can be represented by the expected utility associated with any particular course of action. This has the advantage of being specific about the use of accounting information, with only a minor decrease in generality.

Specifically, we now adopt the Savage Axioms[4] to ensure that the ordering relation, R, admits to a subjective belief and preference factoring such that the accounting alternative providing the maximum expected value of utility is the most preferred alternative. Denote the preference, or utility, factoring $U(\cdot)$ and the belief, or probability, factoring $\Phi(\cdot)$.

To characterize further this expected utility description, we also adopt the conventional specification of an uncertain choice problem. The individual will ultimately select some action $a \epsilon A$ and subsequently observe consequence $x \epsilon X$. Initially, however, he selects accounting alternative $\eta \epsilon$H; signal $y \epsilon Y$ is then produced. If, upon receipt of signal y, action $a \epsilon A$ is taken, and state $s \epsilon S$ actually obtains, the consequence will be $x = p(s, a, \eta)$, where we include η in the outcome function domain to represent the cost of the accounting alternative chosen. The $p(\cdot)$ function is, without loss of generality, completely known; and the probability of observing state $s \epsilon S$ given receipt of signal y from accounting alternative η is denoted by $\Phi(s|y, \eta)$. Also, let $\Phi(y|\eta)$ denote the probability of observing signal y if alternative η is selected. Finally, to avoid regularity difficulties, we assume both Y and S to be finite.

Now, upon receipt of signal y, the most preferred action maximizes conditional expected utility:[5]

$$E(U \mid y, \eta, a_y^*) = \max_{a \in A} \sum_{s \in S} U(p(s, a, \eta)) \Phi(s \mid y, \eta) \tag{1}$$

[2] η preferred to η', then, is $\eta R\eta'$ but not $\eta' R\eta$.

[3] One notable exception here is a multiperson setting where we rely on game theory. See R. Wilson, "A Game Theoretic Analysis of Social Choice," in B. Lieberman, Ed., *Social Choice* (Gordon and Breach, 1971).

[4] L. Savage, *The Foundations of Statistics* (Wiley, 1954).

[5] We naturally assume here and throughout the paper that all indicated maxima exist. A continuous expected value of utility function and nonempty compact choice set are, of course, sufficient to ensure existence.

The most preferred accounting alternative, in turn, maximizes the expected value of utility:

$$E(U \mid \eta^*) = \max_{\eta \in \mathcal{H}} \sum_{y \in Y} E(U \mid y, \eta, a_y^*)\Phi(y \mid \eta) \tag{2}$$

Observe that this characterization of the choice, or specification, of an accounting alternative is but an expected utility variant of the situation initially discussed. We provide for comparison of any pair of alternatives; and our comparisons are transitive. We place these comparisons in an expected utility format simply because it is convenient.

Reliance on standards to specify the most preferred accounting alternative follows a somewhat different tack. The purpose is to select the preferred alternative, but the method of analysis does not rely on subjective opinions and preferences regarding outcomes; rather, it relies on extrinsic properties of the accounting alternatives per se. The authors of ASOBAT, for example, state:

> These standards provide criteria to be used in evaluating potential accounting information. They constitute a basis for inclusion or exclusion of data as accounting information. If these criteria, taken as a whole, are not adequately met, the information is unacceptable. On the other hand, economic data which adequately fulfill these criteria represent accounting material that must be considered for reporting.[6]

One way of characterizing this standards, or criteria, approach is to regard the standards as reflecting the basic qualities of the accounting alternatives irrespective of the individual's beliefs or preferences. For example, objectivity refers to the accounting measurement process per se; similarly, usefulness and relevance refer to the partition induced by the system, irrespective of its cost.

To make this precise, we now assume, without loss of generality, that each $\eta \epsilon \mathrm{H}$ *partitions* the state set. That is, for all $\eta \epsilon \mathrm{H}$ $\cup_{y \epsilon Y_\eta} = S$ and $y \cap y' = \emptyset$ for all y, $y' \epsilon Y\eta$, where $Y\eta$ denotes the set of all $y \epsilon Y$ with $\Phi(y \mid \eta) > 0$. This has the convenient effect of placing all recording, transmission, and similar errors in the state partition; and it allows viewing the information system as defining a function from S *into* $Y: y = \eta(s)$.

Within this framework, the standards are viewed as defining a function, m, from H into the real line such that $m(\eta) \geq m(\eta')$ if and only if $\eta R \eta'$. That is, the standards are used to single out a most preferred alternative. Using the standards, we are able to compare any two accounting alternatives and decide which of the two is superior or whether they are equally desirable. Presumably, the comparisons are also transitive.

One way of describing such a choice process, which we adopt, is to view the standards as providing a hypothetical numerical ranking for each of the alternatives. Note, however, that the domain of this ranking function is limited to H itself, without any reference to the individual's preferences and beliefs.

A fundamental question now arises: does any such function, $m(\cdot)$, exist? In selected settings the answer is, no doubt, affirmative. But, in general, the answer is negative. This is discussed below.

The Impossibility Result

In this section we formally state the assertion that, in general, no set of standards exists that will single out the most preferred accounting alternative without specifically incorporating the individual's beliefs and preferences. We shall focus on an arbitrary set of $i = 1, \cdots, I$ individuals, and assume each to be Savage rational. Then individual i's action choice problem is described by state set S_i, action set A_i, outcome function $p_i(\cdot)$, utility function $U_i(\cdot)$ and probability measure $\Phi_i(\cdot)$. We

[6] *A Statement of Basic Accounting Theory* (American Accounting Association, 1966), p. 8.

now have the following result, which is proven in the Appendix.

THEOREM: *Let* $i=1, \cdots, \mathrm{I}$ *index a set of Savage rational users of information. Further let* $m(\cdot)$ *denote a mapping from the set of information system alternatives into the real line that is independent of the individuals and their choice problems. No measure of information quality* $m(\cdot)$ *exists such that* $m(\eta) \geq m(\eta')$ *if and only if* $E(U_i|\eta) \geq E(U_i|\eta')$ *for all individuals and choice problems and any arbitrary pair of information system alternatives,* η *and* η'.

Discussion

The major significance of this result is to ensure that, generally speaking, we cannot rely on standards to provide a normative theory of accounting. No set of standards exists that will always rank alternatives in accordance with preferences and beliefs —no matter what these preferences and beliefs are, as long as they are consistent in admitting to the expected utility characterization. This negation is, in fact, far reaching. It applies to the use of measure or aggregation theory, as discussed by Ijiri,[7] the use of information theory, as discussed by Lev,[8] as well as the more typical sets of standards, as in ASOBAT. It also applies with equal force to so-called managerial and financial reporting areas. Allocation criteria, such as physical identification, facilities provided, and benefits received do not universally work, nor does a criterion of statistical correlation.

Further observe that the basic difficulty does not rest with a multiperson orientation. We might have a single-person situation or a multiperson setting in which only a dictator's preferences and beliefs counted. Either way, $I=1$ and the Theorem remains.[9] Without restricting the nature of the decision problem faced or the nature of the controlling preferences and beliefs, we simply cannot guarantee that any set of standards will single out the most preferred accounting alternative.

Moreover, a less stringent interpretation of standards does not eliminate the impossibility result. That is, we might interpret the standards as, say, circumscribing the feasible list of alternatives. But this merely amounts to specifying a set of indifferent alternatives (in a feasible sense); and the Theorem goes through with equal force.

We can strengthen, in fact, the result in several respects. Adding beliefs to the analysis does not circumvent the negative result. For example, we might apply objectivity only to those situations we thought might occur with "reasonable probability." This extends the domain of $m(\cdot)$ to systems and beliefs, with $m(\eta, \Phi)$ being the basic mapping. But the Theorem's proof is totally unaffected by such an addition. We could also extend the Theorem to ex post performance evaluation systems as well, where the measurements are designed to motivate subordinate decision makers.[10] But the fundamental conclusion remains: no such ranking function, in general, exists.

Summary

We have interpreted accounting theory as providing a complete and transitive ranking of accounting alternatives at the individual level. It was then proven that

[7] Y. Ijiri, "Fundamental Queries in Aggregation Theory," *Journal of The American Statistical Association* (December 1971).

[8] B. Lev, *Accounting and Information Theory* (American Accounting Association, 1969).

[9] Indeed, another fundamental difficulty arises in a multiperson setting. There is no way of moving from complete and transitive preferences at the individual level to a group level complete and transitive notion of preference that satisfies Arrow's conditions. (K. Arrow, *Social Choice and Individual Values* (Wiley, 1963)). As a result, we expect difficulties in the multiperson case, using standards or any other formulation of the choice process. But standards cannot even be relied upon in the individual case.

[10] See J. Demski, "Optimal Performance Measurement," *Journal of Accounting Research* (Autumn 1972) for a discussion of the relationship between ex ante and ex post information systems.

no set of standards (applied to the accounting alternatives *per se*) exists that will always rank accounting alternatives in relation to consistent individual preferences and beliefs. The major import of the result is to raise a number of questions. We know that standards do not always work. When, then, do they work? Under what types of conditions will various types of standards work; when they fail, how badly do they fail? We know that criteria systems, as in information theory, ASOBAT, or cost-allocation guides cannot be relied upon to provide the desired result in every situation. This does not, however, necessarily imply that they never provide the desired result. Hence, a major question in accounting theory must be conditions under which standards do work.

Appendix

Proof of the Impossibility Theorem relies on a fineness Lemma. We say that η is *as fine as* η' if every signal from η is fully contained in a signal from η'. Alternatively, we say that η is as fine as η' when knowledge of a signal from η is sufficient to construct the corresponding signal from η'. For example, capitalization of human asset values provides an income measurement system that is as fine as a conventional income measurement system; with knowledge of the former measurement one could construct the latter measurement. Similarly, a more timely measurement system is as fine as a less timely system, again because the former measurement can be used to construct the latter. Hence, with η as fine as η', we know that η tells us all that η' tells us, and possibly more.

Now consider two *costless* accounting alternatives, η' and η'', where by "costless" we mean that $p(s, a, \eta)$ is strictly independent of η' and η''. We now have the following result linking fineness to preference between costless information systems:

LEMMA: *Given η' and η'' are costless information systems, $E(U_i|\eta') \geq E(U_i|\eta'')$ for all $i=1, \cdots, I$ and all choice problems if and only if η' is as fine as η''.*[11]

Proof: First suppose η' is as fine as η''. Dropping the i subscript, this implies that

$$\Phi(y'' \mid \eta'') = \sum_{y' \subset y''} \Phi(y' \mid \eta')$$

Next, some algebraic manipulation of equation [2] establishes the desired result:

$$\begin{aligned}
&E(U \mid \eta'') \\
&\quad = \sum_{y'' \in Y} \Phi(y'' \mid \eta'') \max_{a \in A} \sum_{s \in S} U(p(s, a)) \\
&\qquad \cdot \Phi(s \mid y'', \eta'') \\
&\quad = \sum_{y'' \in Y} \sum_{y' \subset y''} \Phi(y' \mid \eta') \max_{a \in A} \sum_{s \in S} U(\cdot) \\
&\qquad \cdot \Phi(s \mid y'', \eta'') \\
&\quad = \sum_{y'' \in Y} \sum_{y' \subset y''} \Phi(y' \mid \eta') E(U \mid y'', \eta'', a_{y''}{}^*) \\
&\quad \leq \sum_{y'' \in Y} \sum_{y' \subset y''} \Phi(y' \mid \eta') E(U \mid y', \eta', a_{y'}{}^*) \\
&\quad = E(U \mid \eta')
\end{aligned}$$

Thus, η' as fine as η'' guarantees $E(U|\eta') \geq E(U|\eta'')$, given both systems are costless.

Now suppose $E(U|\eta') \geq E(U|\eta'')$ for all individuals and any choice problem. Further suppose η' is *not* as fine as η''. We proceed by contradiction. Suppose $S = \{1, 2, 3, 4\}$ and the partitions induced by η' and η'', respectively, are $\{\{1, 3\}, \{2, 4\}\}$ and $\{\{1, 2\}, \{3, 4\}\}$. Observe that $p(1, a) = p(3, a)$ and $p(2, a) = p(4, a)$ for all $a \epsilon A$ implies, for some settings, that

[11] This Lemma is quite close to Blackwell's Theorem. It is, however, more general in that it does not rely on a payoff adequate partition of the state space. See D. Blackwell and M. Girshick, *Theory of Games and Statistical Decisions* (Wiley, 1954) and C. B. McGuire, "Comparisons of Information Structures," Chapter 5 in C. McGuire and R. Radner (eds.), *Decision and Organization* (North-Holland, 1972) for discussion of Blackwell's Theorem. Also see J. Marschak and R. Radner, *Economic Theory of Teams* (Yale University Press, 1971) for discussion of the Lemma and the fact that it ensures that no measure of the quality of information exists.

$E(U|\eta')>E(U|\eta'')$. But $p(1, a)=p(2, a)$ and $p(3, a)=p(4, a)$ for all $a\epsilon A$ implies, for some settings, that $E(U|\eta'')>E(U|\eta')$. This, however, contradicts our assumption and we must, therefore, have η' as fine as η''. ■

We now prove the Impossibility Theorem.

Proof: Since the Theorem is a negative result, we need only provide one counter example. Using the Lemma, an entire class is provided by costless accounting alternatives. The Lemma establishes the necessity of η' as fine as η'' for $E(U_i|\eta')\geq E(U_i|\eta'')$ to hold for all individuals and all action choice problems (given that η' and η'' are costless). Hence, in this case, the standards must rank in accordance with fineness. But, in general, this cannot be accomplished because fineness is an incomplete relation; it does not always hold. (See, for example, the two partitions used in proof of the Lemma.) That is, η' as fine as η'' is necessary and sufficient to ensure that $E(U_i|\eta')\geq E(U_i|\eta'')$, regardless of the individual's preferences, beliefs, and decision problem. But not all systems can be compared with respect to fineness. Thus, the $m(\cdot)$ function sought for cannot exist. This completes the proof. ■